CAVIAR

Preparing the Strategic Road Network (SRN) for Connected and Autonomous Vehicles (CAVs)

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The development of Connected and Autonomous Vehicles (CAVs) has attracted a large amount of attention from both the public and research field. Whilst there has been a plethora of research into CAVs themselves, little is known about how they will operate on the road network, and what modifications are needed to accommodate them within a mixed fleet. In 2019, Galliford Try was awarded £1 million of funding from the National Highways 2019 innovation and air quality competition via Innovate UK to undertake a research project focused on preparing the UK's motorways for CAVs. Working in partnership with Loughborough University and National Highways, the project, named CAVIAR (Connected and Autonomous Vehicles: Infrastructure Appraisal Readiness) was designed to investigate how CAVs will interact with the current road infrastructure whilst also addressing the imbalance in CAV research. To achieve the project's aim of assessing the infrastructure-based CAV failure scenarios, the research team developed an instrumented vehicle equipped with a number of sensors aimed at acquiring roadside data to assess Strategic Road Network (SRN) readiness for safe and efficient CAV operations. The data gathered by the instrumented vehicle was fed into an advanced simulation platform to model how the CAV interacts with its environment.

Key Findings

1. Using inbuilt sensors alone without assistance from other technology, CAVs cannot safely navigate roadworks without the risk of incursion or disengagement. Providing CAVs with advance information about roadworks using Infrastructure to Vehicle (I2V) communication could help overcome this.

2. CAVs need to be given greater precision in understanding their lane position, which could be achieved by updating the digital base map.

3. CAVs have difficulty navigating around stopped vehicles in roadworks. Vehicle to Vehicle (V2V) communication to enable stopped CAVs to communicate with other CAVs could be one way to address this.

Background Information

As transportation technology evolves, more and more car manufacturers are announcing their will to introduce new kinds of vehicles into the automobile market. Such vehicles include CAVs. Although a significant amount of work has been done on the testing of CAVs, little has been done to assess the readiness of the existing infrastructure to accommodate CAVs. The CAVIAR project contributes to reducing this knowledge gap and preparing the Strategic Road Network for a mixed fleet. The CAVIAR project consisted of two phases. The first phase was a feasibility study that identified three CAV disengagement factors on the SRN – roadworks, lane markings, and merging and diverging areas.

The second phase was a demonstrator study which developed these scenarios in detail in an advanced simulation platform and proposed some potential solutions. This phase produced what we believe to be the single largest traffic model to data (J13-16 of the M1).

Phase 3 is currently being developed and will aim to further develop and implement the solutions identified in phase 2.

Methodology.

Phase 1- Feasibility Study

A desk-based literature review was conducted aimed at identifying the main infrastructure-related disengagement factors that cause the CAV to hand back to the human driver. The disengagement factors identified included:

1) Lane markings that are faded or difficult to detect due to other conditions such as low lighting or adverse weather.

2) Roadworks segments, the layout of which differs from the CAV's base map and is thus confusing.

3) Merging and diverging areas, which feature a range of different designs, and involve transitions between low and high-speed roads.

Phase one provided proof of concept for the demonstrator, and in addition to identifying the 3 scenarios, found that:

1. Due to the inherent risks of introducing a CAV to a live highway, the best approach would be to replicate the traffic environment in a simulation environment

2. An integrated simulation platform using a traffic sub-microscopic simulator (PreScan) overlayed with a microscopic simulator (VISSIM) would be the best approach for modelling the highway environment and the surrounding traffic.

Phase 2- Demonstrator Study

The second phase was the demonstrator study, which further investigated the disengagement factors in more detail using data collected by a CAV proxy. The CAV proxy was an instrumented vehicle with a plethora of sensors including lidar, radars, cameras, GPS and V2X communication. The real-time data collected by the CAV proxy was fed into a stimulation/computer model to calibrate and examine how CAVs respond to dynamic lane changes..

This was complemented by a series of "real world" tests run at an off-road development centre. The three key findings identified in our phase 2 study are being taken forward to phase 3: full findings from our research are available on request.

Conclusions and Recommendations

It was clear from our research that the ability of CAVs to operate fully autonomously is not entirely contained within the vehicle technology, and that the roadway infrastructure needs to evolve for CAVs to be able to operate safely on the SRN. With this in mind, the following recommendations were made:

1) Provide CAVs with information about roadworks in advance using infrastructure to vehicle communication (I2V) such as a "smart traffic cone" or "smart barrier".

2) CAVs need to be given greater precision in understanding their lane position, which could be achieved by updating the digital base map.

3) Develop V2V communication to enable stopped vehicles to communicate with other CAVs.